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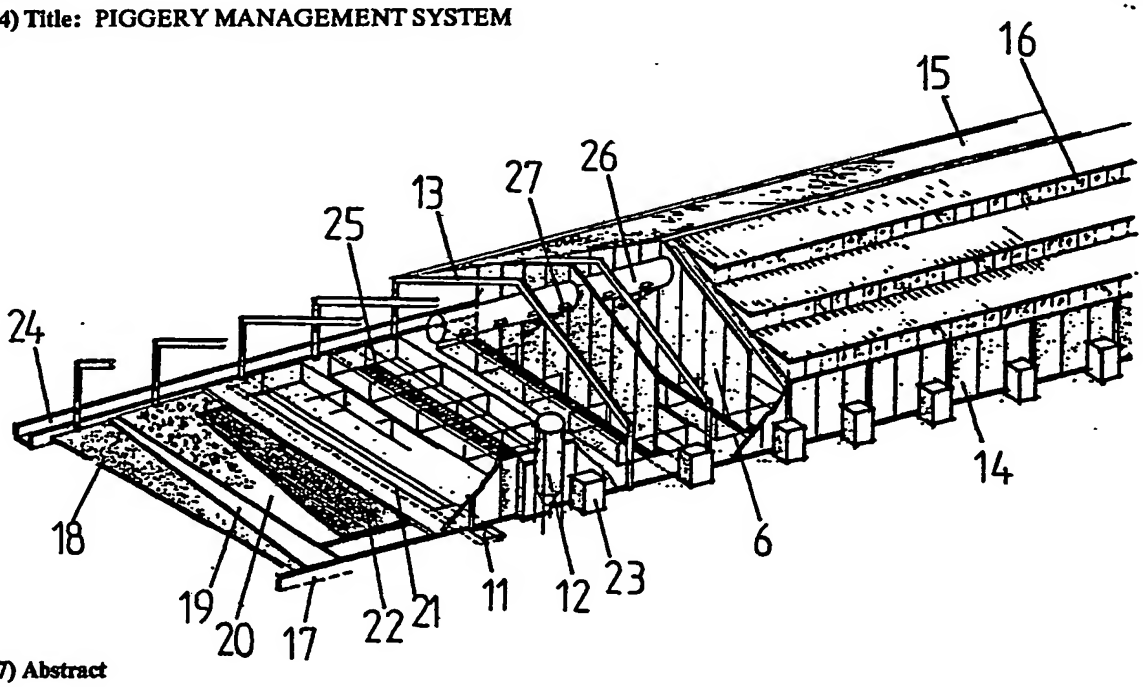

(57) Abstract

A piggery comprises a thermally insulated building structure having a concrete floor (21) divided into a plurality of housing zones (2, 3, 4, 5), each zone including pens for housing groups of pigs. A farrowing zone (3) has regions of floor (44) heated to a predetermined temperature and regions (45) which are unheated. Other zones (4, 5) are heated in their entirety and regions thereof are controlled at different temperature. An elevated air duct (26) provides temperature controlled air which flows downwardly over the housing zones (1, 2, 3, 4, 5) and exits the building via waste channels (11) communicating with a waste duct (24). The piggery system optimizes breeding and growing conditions to provide reduced mortality rates, improved feed conversion rates, better quality meat and reduced operating costs.

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PIGGERY MANAGEMENT SYSTEM

This invention is concerned with an improved piggery management system to provide an optimized environment for breeding and rearing of pigs.

PRIOR ART

Hitherto, large scale piggeries have usually comprised a large fully enclosed building having no provision for environmental control therein. Such structures typically comprise a frame supporting a roof and external wall cladding of corrugated or roll formed steel sheeting. Prior art structures of this type invariably possess a concrete floor and most have at least some drainage channels for collection of animal wastes. Steel mesh fences are often provided to form pens for groups of 20-25 pigs and typically the pens are grouped to provide a dry sow area, farrowing pens, weaner pens and pens for porkers and growers, the pigs being moved from one area to another as required.

Prior art large scale piggery systems are notoriously inefficient on the basis of cost per kilogram of meat produced when compared with operating costs. Indeed, many such piggeries operate on a very fine margin of profit and statistics demonstrate a high rate of commercial failure of such ventures.

The main problem associated with prior art large scale piggeries is their cost inefficiency. Accordingly it is common practice to keep the initial capital cost of construction to a minimum with little regard to an optimized

breeding and growing environment for the pigs.

Prior art commercial piggeries are characterized by high mortality rates in young piglets and low growth rates in surviving pigs.

It has been proposed to provide a piggery in which environmental conditions within the building would be controlled by a recirculating air conditioning system to maintain air temperatures within predetermined limits. Such a proposal has not found favour due to the high initial capital expenditure for the air conditioning system and the high energy consumption costs associated therewith. In addition, recirculating air conditioning systems recirculate a high level of toxic gases such as carbon dioxide from exhaled pig breath and hydrogen sulphide, sulphur dioxide and methane from decomposing animal wastes. Further, airborn bacteria and fungal spores are continuously recirculated throughout the building. Fly growth is also actively promoted.

Notwithstanding the above problems, recirculation of air within a predetermined temperature range does not satisfy the quite differing requirements of mature and immature pigs. Adult pigs for example expel through their skin approximately 3-4 kw of body heat per day and thus require a "cooling" environment. Recently farrowed piglets and, to a lesser extent, weaners, require a source of warmth for their well being.

Accordingly a recirculating air conditioning system

can at best provide only a comprise between the "cooling" and "heating" requirements of mature pigs and piglets respectively with neither having optimum environmental temperature conditions.

One further difficulty associated with recirculating air conditioning systems is associated with the discovery that for air velocities in excess of 0.25 m/sec. substantial hair growth will develop on the skin of a maturing pig. Low air velocities substantially reduce the effectiveness of recirculating air conditioning systems.

It is an aim of the present invention to provide a system which permits optimized environmental conditions for all animals in a commercial piggery while at the same time providing cost effective energy management. The present invention permits reduced animal mortality rates and higher growth rates and the combined benefits of the invention lead to production of pork of substantially improved quality at a substantially lower cost per kg of meat.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of the invention there is provided a piggery comprising:-

a thermally insulated building structure including a concrete floor having a predetermined arrangement of zones for housing pigs of differing levels of maturity, said zones including pens for housing groups of pigs in predetermined numbers;

means to selectively heat predetermined areas of

floor in at least some of said zones;

waste channels recessed into said floor to convey animal waste from said pens to a waste duct located externally of said building structure; and,

one or more air ducts located above said floor to direct via openings in said one or more air ducts a source of temperature controlled fresh air downwardly over said zones and out of said building structure via said waste channels, said piggery characterized in that the temperature environment of each said zone is selectively individually controllable by controlling floor temperatures and/or air flow temperatures associated with each said zone.

Preferably said waste channels include apertured covers and most preferably waste channels associated with pens of differing zones communicate with flushing means to remove waste therefrom to said waste duct.

Suitably said means to selectively heat predetermined areas of floor comprises heat exchange means located within said floor. Preferably said heat exchange means comprises ducting members in fluid communication with a source of heated fluid.

If required each said heat exchange means may be individually controllable to selectively heat each said predetermined area of floor or alternatively groups of heat exchange means associated with a selected zone may be controllable to selectively heat predetermined areas of floor of a group of pens associated with a selected zone.

The source of heated fluid preferably comprises one or more storage tanks containing heated water. The water may be conveniently heated by any suitable heating means such as electric element or fuel heating means but preferably comprises a solar heating means and/or a heat pump adapted to extract heat from air collected in said waste duct.

Preferably said floor includes insulation means in the form of thermal barriers to reduce lateral heat losses in said floor. The floor may include a thermal barrier about all or part of the perimeter of the floor structure. Suitably, thermal barriers are provided to surround selectively heated predetermined areas of floor in said at least some of said zones.

According to a further aspect of the invention there is provided a method of operating a piggery under controlled environmental conditions comprising the steps of:- housing in a thermally insulated building structure groups of pigs in predetermined numbers in predetermined zones according to the level of maturity of said pigs;

selectively heating predetermined areas of floor in at least some of said zones; and,

directing downwardly at a predetermined velocity a flow of temperature controlled fresh air from one or more air ducts located above said floor and redirecting said flow of air out of said building structure via a plurality of waste channels recessed into said floor to a waste

collection duct located externally of said building structure, characterized in that the temperature environment of each said zone is selectively individually controllable by controlling floor temperatures and/or air flow temperature associated with each said zone.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more fully appreciated, reference is made to a preferred embodiment illustrated in the accompanying drawings. In the drawings:-

FIG 1 shows a typical floor plan of a piggery according to the invention,

FIG 2 shows schematically constructional aspects of the piggery of FIG 1,

FIG 3 illustrates a cross sectional view of the piggery structure showing air flow therewithin,

FIG 4 shows a part sectionalized area of floor construction,

FIG 5 shows a part sectionalized area of floor heating and service duct,

FIG 6 shows a part sectionalized area of a farrowing cage,

FIG 7 shows a part sectionalized area of a weaner cage,

FIG 8 shows a diagrammatic layout of portion of the waste channel system and effluent circulation system.

DETAILED DESCRIPTION OF DRAWINGS

FIG 1 shows a plan view of a piggery with portion

represented by FIG 1a and the continuation of FIG 1a represented by FIG 1b.

The piggery is designed to support 180 sows and the total population (including boars and immature pigs) is 2062 pigs of various sizes.

The piggery is divided into a number of zones for various functions. These zones include the boar zone 1, dry sow zone 2, farrowing zone 3, weaner zone 4, and the porker and grower zone 5. The various zones are divided by steel fences into pens and the farrowing zone is divided by walls 6 and partitions 7. The weaner zone 4 is delineated by walls 6a, 6b. Walls 6 extend only partially across the building structure leaving walkways 8 on each side of the farrowing and weaner zones 3, 4 respectively. Longitudinal and transverse walkways 9, 10 respectively are provided elsewhere.

Extending transversely of the individual pens in each zone are waste channels 11 shown in phantom. Feed storage silos 12 are provided at convenient locations along an outer wall of the structure.

FIG 2 illustrates some of the constructional features of a preferred embodiment.

The structure comprises a plurality of spaced steel portal frames 13 with walls 14 and roof 15 fabricated from thermally insulated panels. Where circumstances permit the structure is aligned east-west with north or south facing windows 16 (depending upon hemispherical location) to

optimise available natural sunlight. In hotter climates these windows make open to assist in ventilation of the building.

The portal frames 13 are supported on perimeter foundations 17 and a concrete floor 21 is formed over various layers of gravel 18, sand 19, insulating material 20. In selected regions of floor, heat exchange conducts 22 are embedded in the concrete layer 21.

Formed in the concrete floor 21 are transverse waste channels 11 having an inlet on one side of the building to receive periodically from containers 23 a volume of water which flushes waste material to the other side of the building for collection in waste duct 24. The waste channels are covered with apertured grates 25.

Supported adjacent the inside of roof 15 is an air duct 26 having a plurality of registers 27 to direct air downwardly towards the floor 21.

FIG 3 shows a cross sectional view of the structure of FIG 2. When air is pumped into the closed building structure at a pressure slightly above atmospheric pressure, the air flow is directed downwardly and substantially evenly over the floor area by registers 27 in air duct 26 as shown by the arrows. The air then enters channel 11 and escapes from the building via waste duct 24. If required a barometric trap may be installed at the junction of each channel 11 and duct 24 to assist control of air flow in the building.

By maintaining such a positive pressure and directional air flow, ingress of insects such as flies is prevented and toxic gases from expired air and decomposing waste is swept away from pigs contained in the building. In addition dust from dry fodder is swept towards channels 11 thereby preventing inhalation by the pigs.

FIG 4 shows a part sectionalized view of a floor construction adjacent an outer walkway 30. In the farrowing, weaner, porker and grower zones shown in FIG 1 there is a walkway down each side of the building. The walkway 30 comprises a cast concrete layer 31 formed on a sheet plastics moisture barrier 32 under which is a layer of sand 33 and a layer of gravel 34.

Formed in the walkway 30 is a service duct 35 for service conduits such as water pipes 36. Removable covers 37 are provided to close the service duct 35. Walkway 30 is separated from adjacent pens 38, 39 by a steel barrier 40. A layer of insulating material 41, e.g. "Styrofoam" (Trade Mark) is located under the floor slabs 38a, 39a of pens 38,39 to reduce heat losses therethrough.

Waste channel 11 is formed at the junction of adjacent pens 38, 39 and waste is collected therein via grates 25. A removable floor panel 42 covers channel 11 where the channel passes under the walkway.

FIG 5 is a similar view to that of FIG 4 and shows heat exchange elements 43 embedded in the concrete floor slabs of pens 38, 39. The heat exchange elements 43

comprise corrosion resistant material such as an extruded synthetic plastics or rubber tubing connected to conduits 36 to provide a means for circulating heated water through the heat exchange elements to heat selected areas of floor. The insulating barrier 41 prevents heat loss to the ground.

FIG 6 shows a part sectionalized view of a farrowing cage. Within the floor of each cage are two large areas and two small areas heated by heat exchange elements 43 in respective corners of the cage area. Between the heated areas 44 is a non-heated area of cruciform shape 45. In this manner the young piglets are provided with warm floor areas away from the cooler floor area preferentially occupied by the sow. Apart from feeding times the piglets are thus encouraged to stay away from the sow and the high mortality rate associated with crushing of the piglets by the sow is reduced substantially.

FIG 7 shows a similar view of a weaners cage wherein the entire floor area is able to be heated by heat exchange elements 43. As the weaners cage is not occupied by a sow, large populations of piglets may be accommodated in a comfortable manner under conditions conducive to rapid growth.

FIG 8 shows portion of a recirculating waste system. Animal wastes are flushed from waste channels 11 into waste duct 24 and thence to a sedimentation pit 50. Solids free water is extracted from the upper part of the

pit 50 and pumped via pump 51 back to flushing tanks 23 for re-use. If required, the separated solids may be extracted by a further pump 52 for use in a bio-mass converter to produce heat energy for the piggery.

The piggery system according to the invention is adaptable to a wide variety of ambient conditions from sub-tropical climates through to very cold climates.

In sub-tropical climates a degree of cooling may be required to maintain optimum air temperatures within the piggery. Cooling of air may be achieved by conventional means such as an evaporative cooler or a refrigerated cooling system.

Alternatively in colder climates waste body heat from the pigs may be utilized to provide a heat source for air or floor heating. For example in a 180 sow piggery described above operating in ambient conditions of -25 degrees C, the heat energy required to maintain optimum air and floor heating is 5118 kw per day. The total population in such a piggery is 2062 pigs which produce waste body heat of 6731 kw per day.

By covering the waste duct 24 and circulating waste air collected therefrom through a heat pump, low temperature heat energy is extracted and stored in insulated hot water tanks. As required the stored heat may be circulated through the floor heating system and/or through heat exchangers in the air duct to heat incoming fresh air. The energy required to operate a suitable capacity heat pump is

estimated at 71 kw per hour. Greater energy efficiencies may be achieved by utilizing a heating system fuelled by a bio-mass conversion system.

Temperature control of the floor heating systems may be achieved by any suitable means such as thermostatically controlled valves and selected areas may be heated as required by opening isolation valves connected either to individual pens or to banks of pens within particular zones.

The following table shows optimum floor temperatures for piglets.

AGE	ZONE	TEMPERATURE
New born	Farrowing	33 degrees C
1 week	"	32 degrees C
2 weeks	"	31 degrees C
3 weeks	"	30 degrees C
4 weeks	"	29 degrees C
1st week	Weaning	28 degrees C
subsequent weeks	"	reduced by 1 degree C per week to 25 degrees C.
	Porkers/Growers	No floor heating required.

Temperature control of incoming fresh air is controlled by thermostatic sensors located in each zone just above the pigs. The thermostatic sensors control the supply of heated fluid from storage tanks to heat exchanges located within a plenum in the air duct and similarly control an air damper or the like associated with a cooling system.

By providing an optimized environment for breeding and growing of pigs substantial benefits are obtainable to a

grower. Substantially reduced mortality rates can be expected by providing heated areas in the farrowing zone as well as post farrowing mortalities due to increased disease resistance.

Under optimized growing conditions a reduced feed cost can also be expected. Feed conversion rates of as low as 3.5 can be reasonably achieved compared with a prior art rate of 4.1 hitherto regarded as the best rate achievable under normal growing conditions.

A further benefit which will accrue to the grower is a substantially improved meat quality. Pork grown under optimized conditions according to the invention is substantially whiter in colour and more even in texture and at the same time substantially leaner.

CLAIMS

1. A piggery comprising:-

a thermally insulated building structure including a concrete floor having a predetermined arrangement of housing zones for housing pigs of differing levels of maturity, said housing zones including pens for housing groups of pigs in predetermined numbers;

means to selectively heat predetermined areas of floor in at least some of said housing zones;

waste channels recessed into said floor to convey animal waste from said pens to a waste duct located externally of said building structure; and,

one or more air ducts located above said floor to direct via openings in said one or more air ducts a source of temperature controlled fresh air downwardly over said housing zones and out of said building structure via said waste channels, said piggery characterized in that the temperature environment of each said housing zone is selectively individually controllable by controlling floor temperatures and/or air flow temperatures associated with each said housing zone.

2. A piggery as claimed in claim 1 wherein said means to selectively heat predetermined areas of floor comprises heat exchange means located within said floor.

3. A piggery as claimed in claim 2 wherein said heat exchange means comprises ducting members in fluid communication with a source of heated fluid.

4. A piggery as claimed in claim 3 wherein said predetermined areas of floor are bounded by thermal barriers to reduce lateral heat transfer within said floor.

5. A piggery as claimed in claim 3 wherein means are provided to selectively control floor temperatures in selected housing zones.

6. A piggery as claimed in claim 5 wherein said heat exchange means comprises ducting members individually controllable or controllable in selected groups to heat said predetermined areas of floor.

7. A piggery as claimed in claim 1 wherein thermostatic control means is associated with each said housing zone to control the temperature of air directed over said zones from said one or more air ducts.

8. A piggery as claimed in claim 7 wherein said thermostatic control means is located at a height of from 300 mm to 1000 mm above the surface of the floor in each said housing zone.

9. A piggery as claimed in claim 1 wherein the velocity of air directed over each said housing zone is less than 0.2 metres per second.

10. A piggery as claimed in claim 1 including one or more liquid storage tanks to store heated liquid as a source of heat for heating said predetermined areas of floor and/or controlling the temperature of fresh air directed over said housing zones.

11. A piggery as claimed in claim 10 wherein solar energy collection means is provided to heat liquid stored in said one or more liquid storage tanks.

12. A piggery as claimed in claim 10 wherein a heat pump is provided to extract heat from air expelled from said building structure via said waste channels, said heat pump being in operative communication with said one or more liquid storage tanks to heat a liquid contained therein.

13. A method of operating a piggery comprising the steps of:-

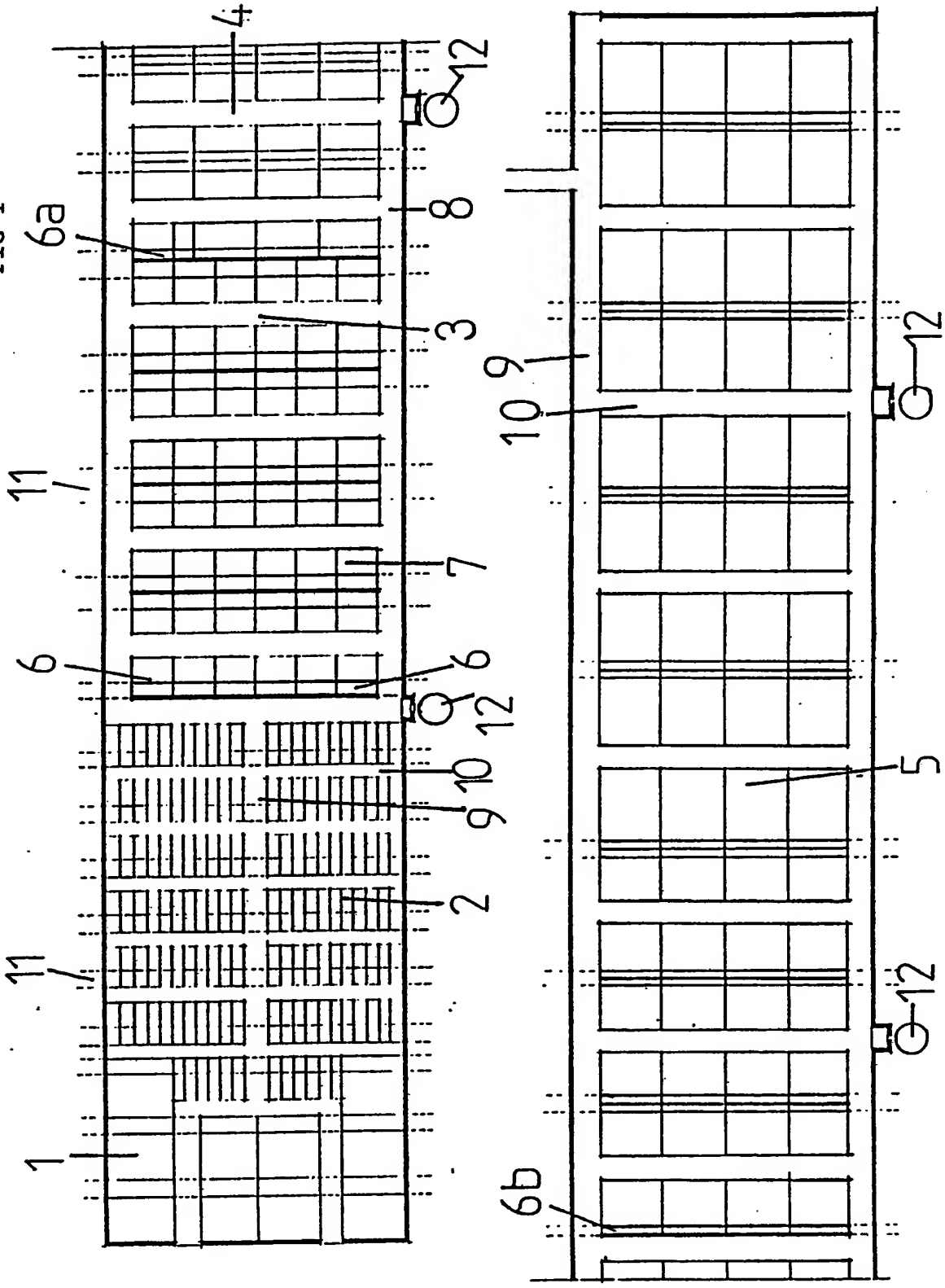
housing in a thermally insulated building structure groups of pigs in predetermined numbers in predetermined housing zones according to the level of maturity of said pigs;

selectively heating predetermined areas of

floor in at least some of said zones; and,

directing downwardly at a predetermined velocity a flow of temperature controlled fresh air form one or more air ducts located above said floor and redirecting said flow of air out of said building via a plurality of waste channels recessed into said floor to a waste collection duct located externally of said building structure, said method characterized in that the temperature environment of each said housing zone is selectively individually controllable by controlling floor temperatures and/or air flow temperatures associated with each said housing zone.

FIG 1



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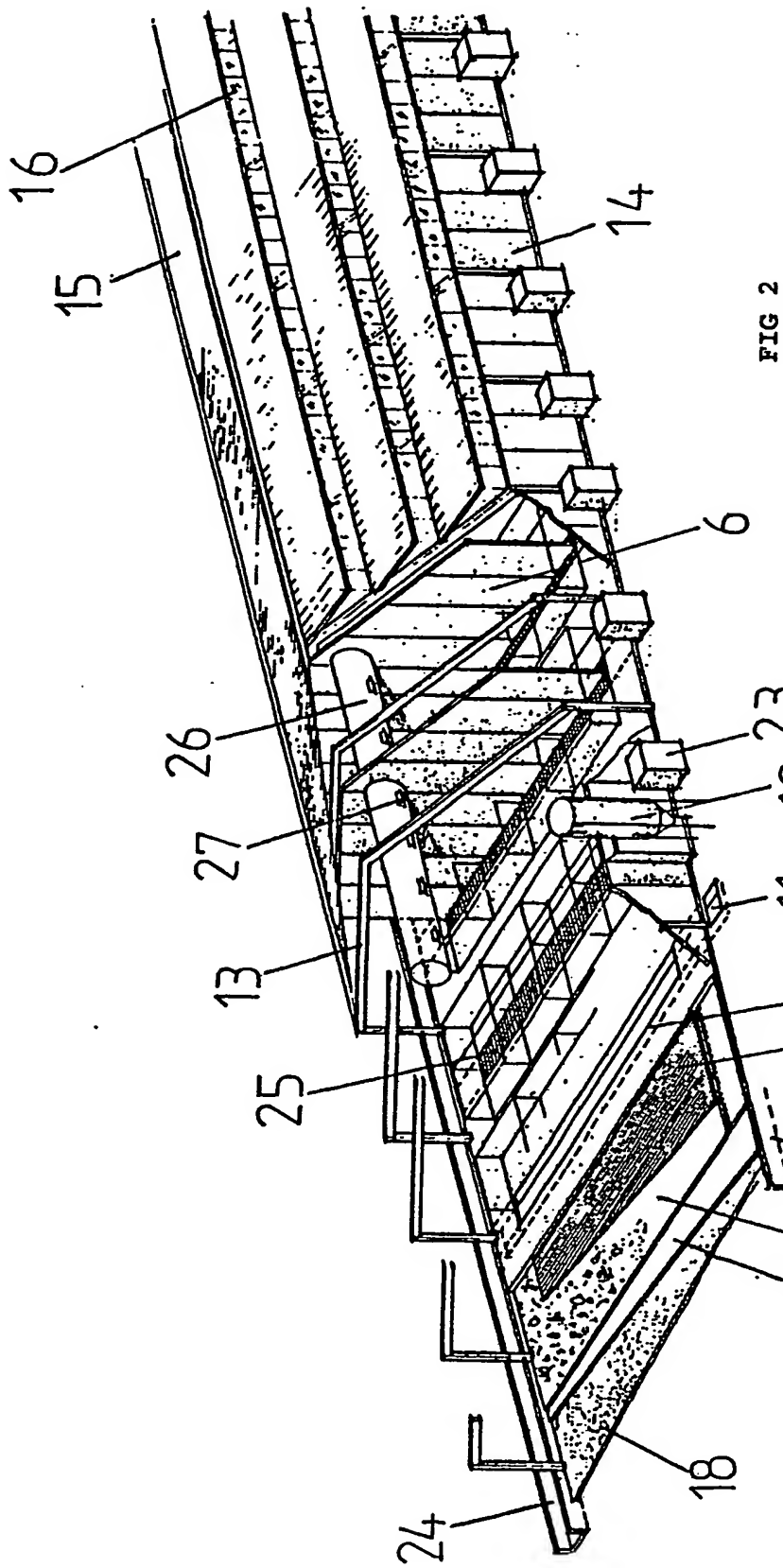


FIG 2

FIG 3

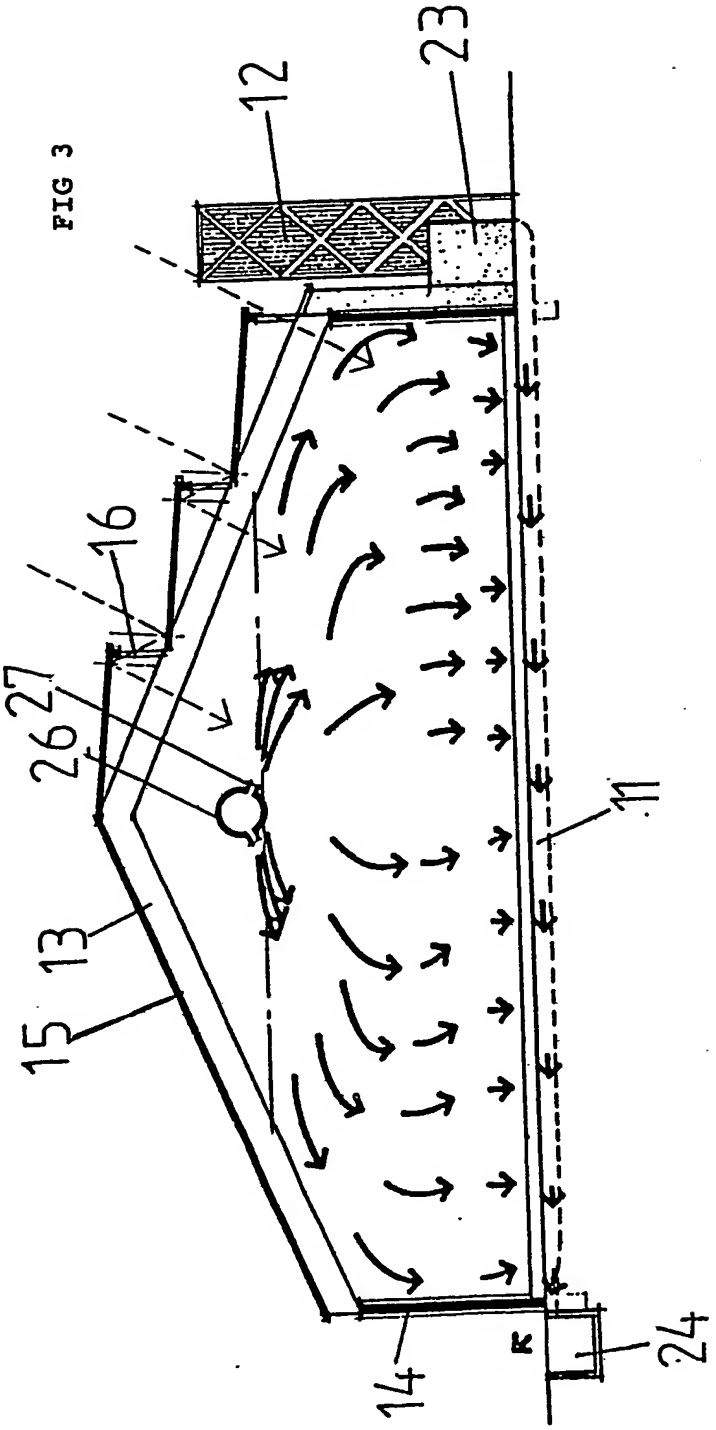


FIG 4

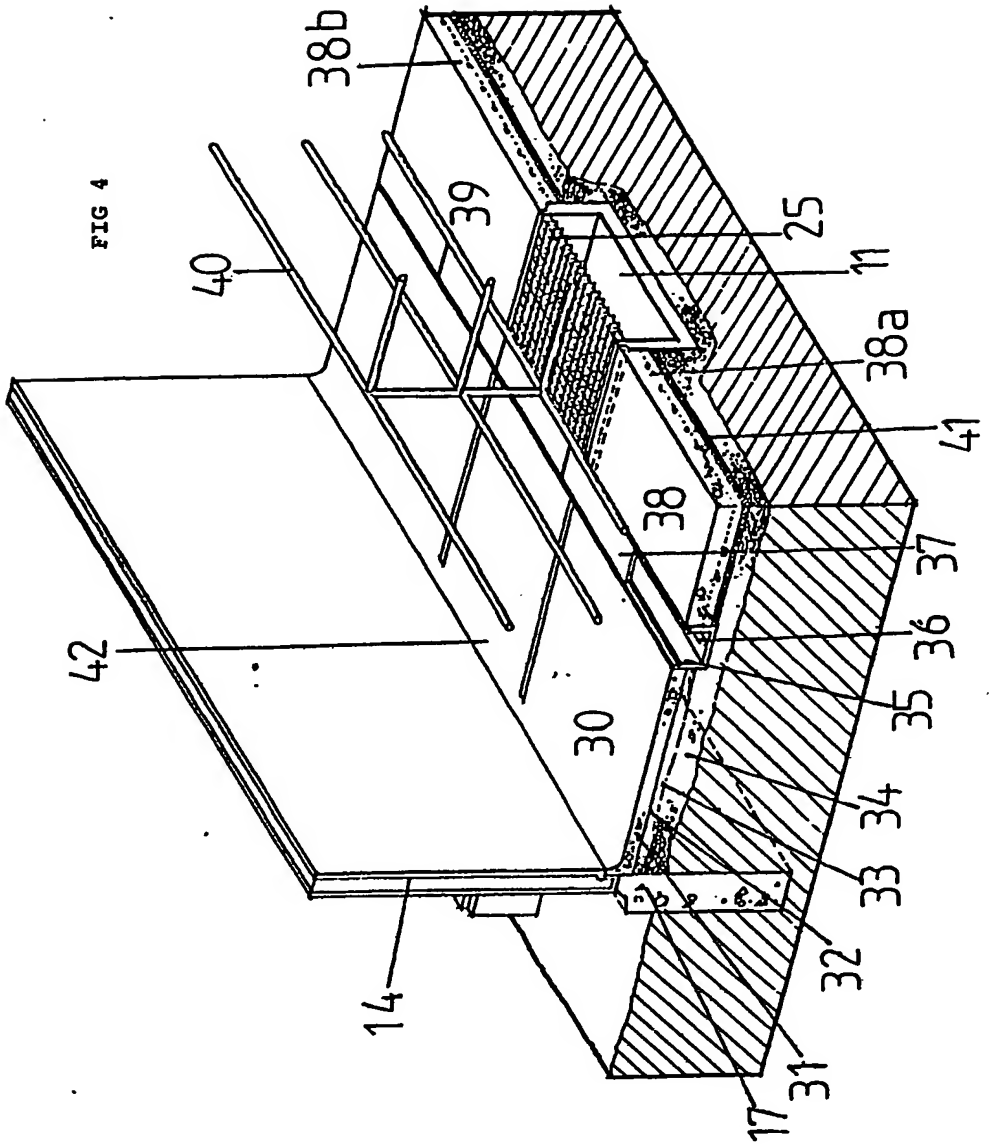
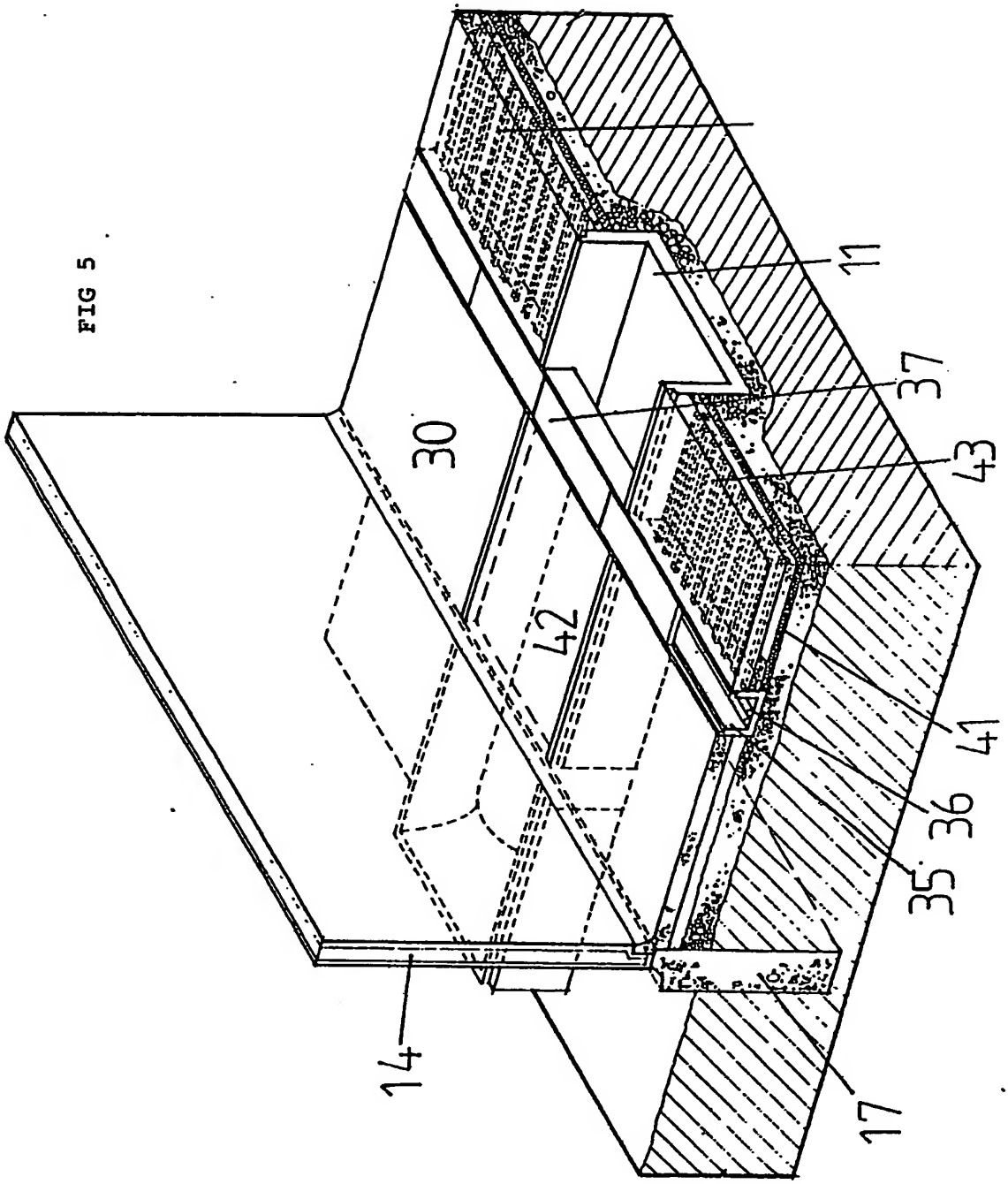


FIG 5



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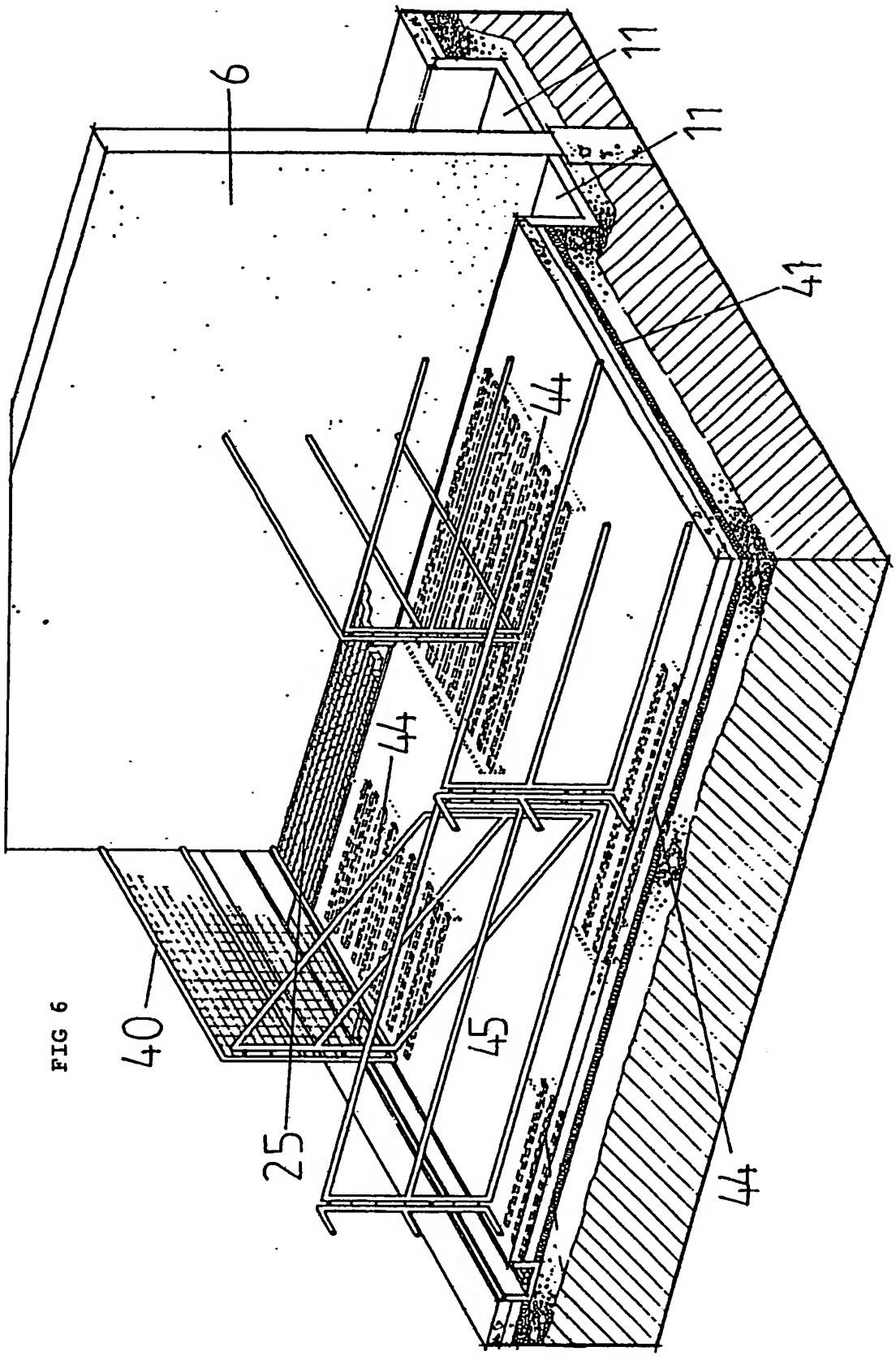

FIG 6

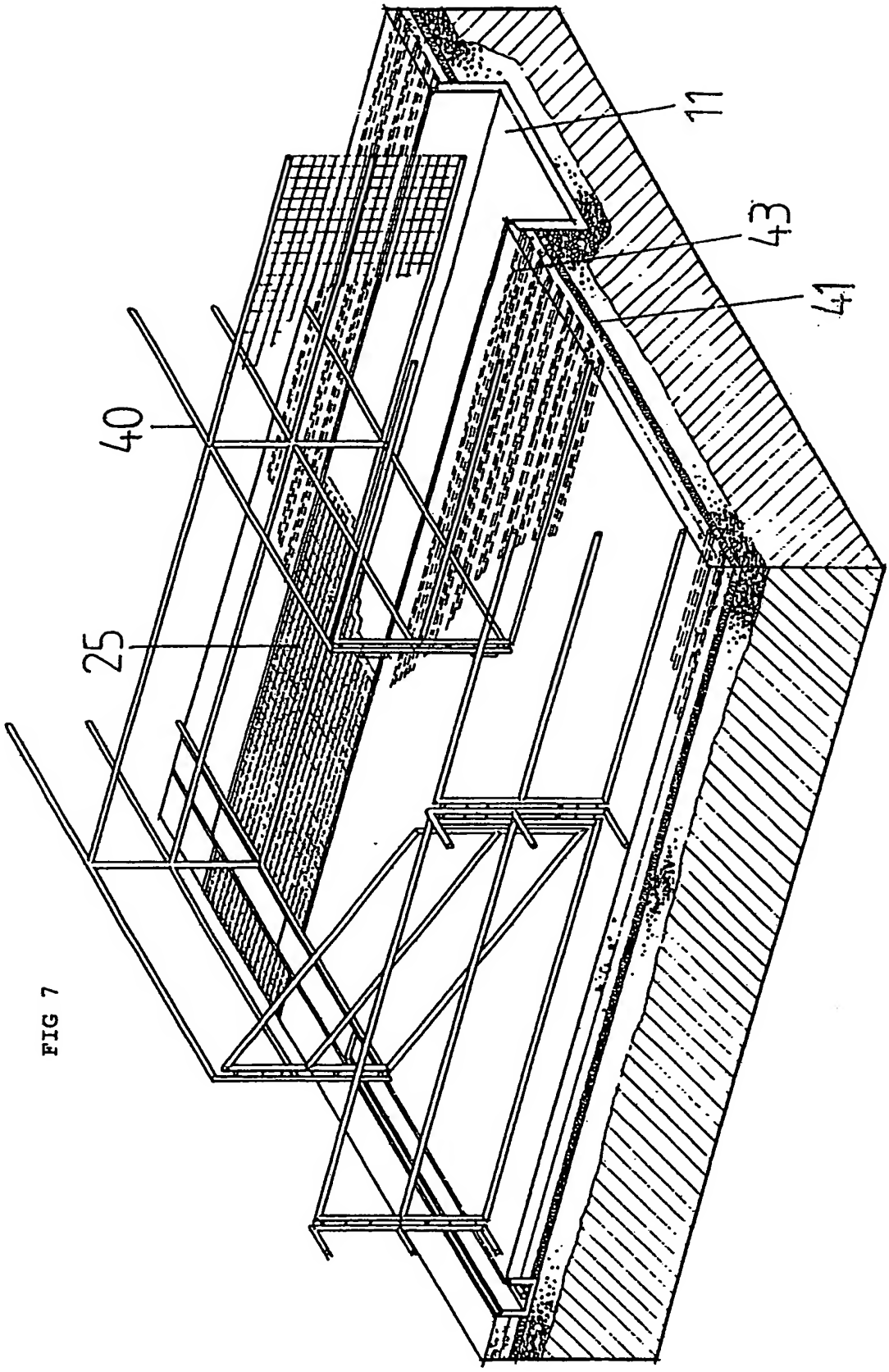

FIG 7

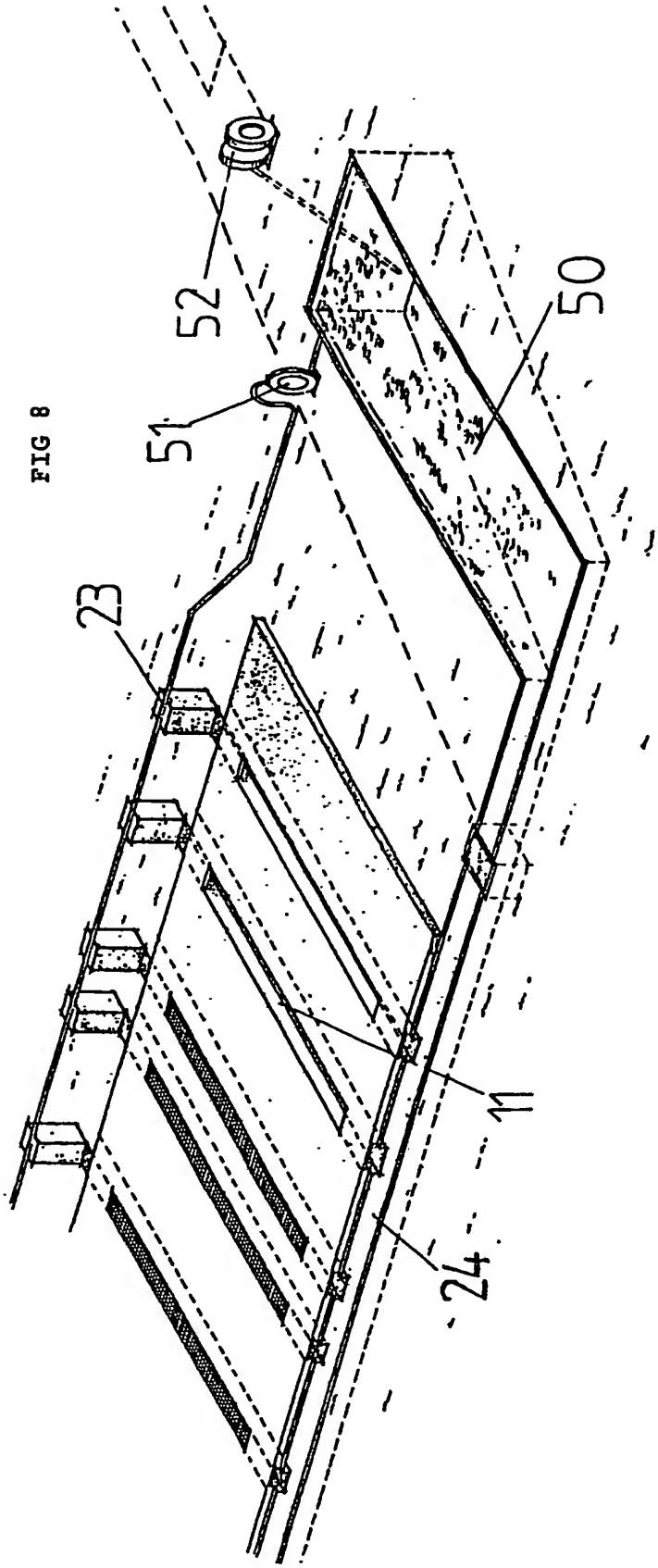

FIG 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00191

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] A01K 1/02

II. FIELDS SEARCHED

Minimum Documentation Searched †

Classification System	Classification Symbols
IPC	A01K 1/02

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched ‡

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT §

Category *	Citation of Document, ‖ with indication, where appropriate, of the relevant passages ‖	Relevant to Claim No. ‖
X	AU,A, 53180/73 (INTERNATIONAL FARM SYSTEMS, INC.) 12 September 1974 (12.09.74)	(1-13)
Y	US,A, 4217859 (HERRING) 19 August 1980 (19.08.80)	(1-13)
Y	US,A, 4239020 (KIYOKAWA AND SAKAGUCHI) 16 December 1980 (16.12.80)	(1-13)
A	US,A, 3181503 (TRIPP) 4 May 1965 (04.05.65)	
A	US,A, 4478175 (FISHER AND HOLMAN) 23 October 1984 (23.10.84)	

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27 October 1987 (27.10.87)	(06.11.87) 6 NOVEMBER 1987
International Searching Authority: Australian Patent Office	Signature of Authorized Officer: P. WARD

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00191

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members			
AU 53180/73	JP 49054169	US 3779210	IT 972348	
US 4239020	CH 628948	DE 2915805	FR 2449398	
	GB 2041715	JP 55112941	NL 7903064	
US 4478175	AU 79450/82	CA 1182005	DK 137/82	
	EP 56336	ES 509117	ES 8303018	
	FI 820108	JP 57138329	NO 820093	

END OF ANNEX